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Evolution of Magnetic and Electronic Properties of Spinel $\text{Cr}_x\text{Fe}_{3-x}\text{O}_4$ Thin Films

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In this study, by substituting Cr in Fe_3O_4 , $\text{Cr}_x\text{Fe}_{3-x}\text{O}_4$ thin film samples were prepared by sol-gel method on Si(100) substrates. The samples were found to be polycrystalline in nature and the Cr-doped ones maintained the same structure as that of Fe_3O_4 up to $x = 0.95$ without any secondary phases. The lattice constant is decreased slightly with increasing Cr composition with the value for $x = 0.95$ reduced by 0.05% compared to that of Fe_3O_4 . The decrease of lattice constant can be explained in terms of substitution of octahedral Fe^{3+} sites by Cr^{3+} ions. The $\text{Cr}_x\text{Fe}_{3-x}\text{O}_4$ films were found to exhibit n-type character with resistivity increasing with increasing Cr content.

Magnetic hysteresis curves of the samples measured at room temperature indicate that the saturation magnetization (M_s) increase at low Cr composition ($x \leq 0.05$) and decrease as x increases further. On the other hand, the coercivity (H_c) increases as x increases. Simple comparison of the spin magnetic moment of Cr^{3+} and Fe^{3+} ions can not explain the increase of M_s . The increase of M_s is attributable to the unquenched orbital angular momentum of octahedral Fe^{2+} ion [1] due to perturbation of octahedral Cr^{3+} ions existing nearby. The increase of H_c is attributed to the increase of magnetic anisotropy by the existence of octahedral $\text{Cr}^{3+}(\text{d}^3)$ ions. Magnetoresistance of $\text{Cr}_x\text{Fe}_{3-x}\text{O}_4$ films is found to decrease with increasing x as shown in Fig. 1 and the probable reason for it is discussed.

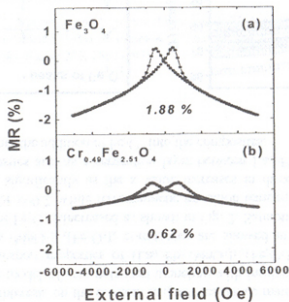


Fig. 1. Magnetoresistance measured for (a) Fe_3O_4 and (b) $\text{Cr}_{0.46}\text{Fe}_{2.51}\text{O}_4$ thin films at room temperature.

REFERENCES

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